OHIO PLANTS WITH PUNCTATE GLANDS AND GLANDULAR SCALES AND PUBESCENCE.

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The subject of glands is interesting from a morphological as well as from a physiological stand-point. In their morphology plant glands represent very diverse structures and in the following article an attempt has been made to classify certain types of Ohio glandular plants as a basis for future ecological and physiological studies. In this paper resin ducts as are present in the stems and leaves of Conifers will not be considered.

There are about sixty Ohio plants which have internal punctate glands such as are found typically developed in the Polygonums and Hypericums. These glands can usually be seen with the naked eye if the leaf is held up to the light, but with the aid of a small lens all are quite distinctly seen. The glands usually appear light in color, but some are black and a few yellow. The size is variable but usually the smaller the glands the more numerous they are.

Most punctate glands are internal although some leaves, as the prickly ash, have the epidermis modified into large cells which are probably used in secreting the contents of the gland. The gland of the prickly ash (Fig. 1) is made up of many layers of modified cells, each cell having a prominent nucleus. The cell and nucleus stain about the same color as the palisade tissue. In most of the cross-sections of the leaves the glands are about as deep as the palisade tissue, but in some of the older leaves, where development is complete the glands extend far down into the spongy tissue (Fig. 2). At the top of each gland of prickly ash there are a number of cells entirely different from the ordinary epidermal cells. They are larger than the epidermal cells, stain about as dark as the palisade tissue and have large dark nuclei. They are very conspicuous in a cross-section showing as a row of from three to six cells across the top of the gland, but in a tangential section they appear in a more or less circular plate of from nine to thirty-six cells.

The internal glands of the Hypericum (Fig. 5) are of much the same type, but differ in two particulars. Instead of having a many-layered gland-wall, the wall is thin, being made up of a single layer of cells. These cells stain darker than any other part of the leaf. The cell usually extends about as deep as the palisade tissue, although most of the sections of Hypericum show a double row of palisade. The second point of difference between this and the prickly ash is that the Hypericum does not have the compact plate of cells in the epidermis. The covering above the gland appears perfectly normal. Hypericum maculatum has black dots instead of the light ones. These black dots

have practically the same structure as the light glands, but are made dark by the secretion which is contained in them. The age of the leaf may also have some influence on the darkness of the spot.

The glands of Boebera papposa (Fig. 4) appear to the naked eye as large yellow spots, oval in shape. The gland wall is very thick being made up of a number of layers of cells like the prickly ash. The cells composing the wall stain quite dark on the outside, but the inner layers take the stain much less prominently. The cells in the innermost layer are irregular in shape and remain very light in color. They are sharply limited from the adjoining layer by a definite heavy wall. The gland is a little less than twice as long as broad, and extends from the upper epidermal layer to the lower epidermis.

The internal glands of this type usually secret volatile oils, but the glandular peltate scales found on the surface of the leaves and stems very commonly secret resin, although no absolute distinction can be made. Gaylussacia resinosa (Fig. 8) is provided with external scales on the under side of the leaf. These scales are attached to the leaf by stalks which are made up of about seven cells. The scale itself is divided into from six to ten cells. The resin is secreted from this and as the scale becomes mature the outer covering is pushed off by the secretion. This produces a bulging out of the scale, and the whole structure is surrounded by a mass of bright yellow resin. The illustration shown in most texts of this type is the gland found on the bracts of the common hop Humulus lupulus, but the hop gland is more simple in structure. The cross-section of the leaf of Gaylussacia shows no further adaptation for secretion, and even the lower epidermal covering is perefctly normal. The longitudinal section shown (Fig. 9) is cut through the base of the disc and therefore shows one central cell of the stalk and eight surrounding cells of the scale proper. These cells show rather large dark nuclei and contain abundant cytoplasm.

In Glecoma hederacea, common ground ivy, (Fig. 7), resin is also secreted, but the position of the scale is somewhat different. Instead of secreting scales on the surface of the epidermis, the organs for this purpose are in depressions or pits. The gland has a stalk of two cells and below a scale showing a row of from three to six cells in cross-section. These cells stain quite dark but the nuclei can be seen without difficulty. The outer wall of the scale is separated from the protoplasm of the cells by a definitely limited clear space.

Besides the glandular tissue on the inside and glandular scales, other glandular structures are developed from the epidermis which represent true epidermal hairs or emergences. The hairs may be of different types, unicellular or multicellular.

Corylus americana (Fig. 12) has glandular emergences of the multi-cellular type. The stalks show from five to ten rows of cells on one side and the glandular heads are also multi-cellular. Cypripedium reginae (Fig. 11) has multi-cellular glandular hairs consisting of three stalk cells and a head cell. The basal cell is rather large and extends below the surface of the epidermis. The top or head cell is enlarged and rounded in shape with a slight depression on the top. The four cells each show large nuclei and the head cell is filled with granular cytoplasm. Juglans has glandular hairs which have multi-cellular heads. The cells are formed by longitudinal divisions and a plate of cells is formed. The stinging hairs of Urtica dioica (Fig. 10) are glandular, but of a different type. The hair consists of an enlarged multi-cellular base and a single-celled top. This hair gives our formic acid on being broken.

The following lists represent the Ohio plants having the various types of glands considered:

PUNCTATE LEAVES.

Polygonum incarnatum Ell.
" lapathifolium L.
" pennsylvanicum L.
" persicaria L.
" careyi Olney.
" hydropiperoides Michx.
" hydropiper L.
" punctatum Ell.
" virginianum L.
" scandens L.
" sagittatum L.
" arifolium L.
Amaranthus hybridus L.
" retroflexus L.
" spinosus L.
" blitoides S. Wats.
" graecizans L.
Acnida tamariscina tuberculata (Moq.) Uline and Bray.
Magnolia acuminata L.
Liriodendron tulipifera L.
Caltha palustris L.
Psoralea pedunculata (Mill.) Vail.
Psoralea onobrychis Nutt.
Amorpha fruticosa L.
Kuhnistera purpurea (Vent.) MacM.
Xanthoxylum americanum Mill.
Ptelea trifoliata L.
Polygala cruciata L.
" verticillata L.
" ambigua Nutt.
" incarnata L.
Polygala viridescens L.
" senega L.
" polygama Walt.
" paucifolia Willd.
Ascyrum hypericoides L.
Hypericum ascyron L.
" kalmianum L.
" prolificum L.
" adpressum Bart.
" spaerocarpum Michx.
" ellipticum Hook.
" virgatum Lam.
" maculatum Walt.
" perforatum L.
" subpetiolatum Bickn.
" boreale (Britt.) Bickn
" mutilum L.
" gymnanthum Engelm. and Gray.
" majus (Gr.) Britt.
" drummondii (Grev. and Hook.) T. and G.
Triadenum virginicum (L.) Raf.
Lysimachia quadrifolia L.
" terrestris (L.) B. S. P.
" nummularia L.
Naumbergia thyrsiflora (L.) Duby.
Grindelia squarrosa (Pursh) Dunal.
Euthamia graminifolia (L.) Nutt.
" caroliniana (L.) Greene.
Boebera papposa (Vent.) Rydb.

Glandular Scales.

Myrica cerifera L.
Comptonia peregrina (L.) Coult.
Betula populifolia Marsh.
" alba pendula Hortorum.
" nigra L.
" lenta L.
" lutea Mx. f.
" pumila L.
Ribes floridum L'Her.
Gaylussacia resinosa (Ait.) T. & G.
Glecoma hederacea L.
Monarda didyma L.
" clinopodium L.
" fistulosa L.
Blephilia ciliata (L.) Raf.
" hirsuta (Pursh.) Torr.
Clinopodium glabrum (Nutt.) Kuntze.
" vulgare L.
Origanum vulgare L.
Koellia flexuosa (Walt.) MacM.
" virginiana (L.) MacM.
" pilosa (Nutt.) Britt.
" incana (L.) Kuntze.
" mutica (Michx.) Britt.
Thymus serpyllum L.
Cunila origanoides (L.) Britt.
Lycopus virginicus L.
" rubellus Moench.
" americanus Muhl.
Mentha spicata L.
" piperita L.
" citrata Ehrh.
" longifolia (L.) Huds.
" arvensis L.
" sativa L.
" canadensis L.
Collinsonia canadensis L.
Eupatorium perfoliatum L.
" coelestium L.
" altissimum L.
Lacinaria squarrosa (L.) Hill.
" cylindracea (Michx.) Kuntze.
" scariosa (L.) Hill.
Grindelia squarrosa (Pursh.) Dunal.
Tetraneuris acaulis (Nutt.) Greene.
Helenium autumnale L.
" nudiflorum Nutt.
" tenuifolium Nutt.
Helianthus strumosus L.

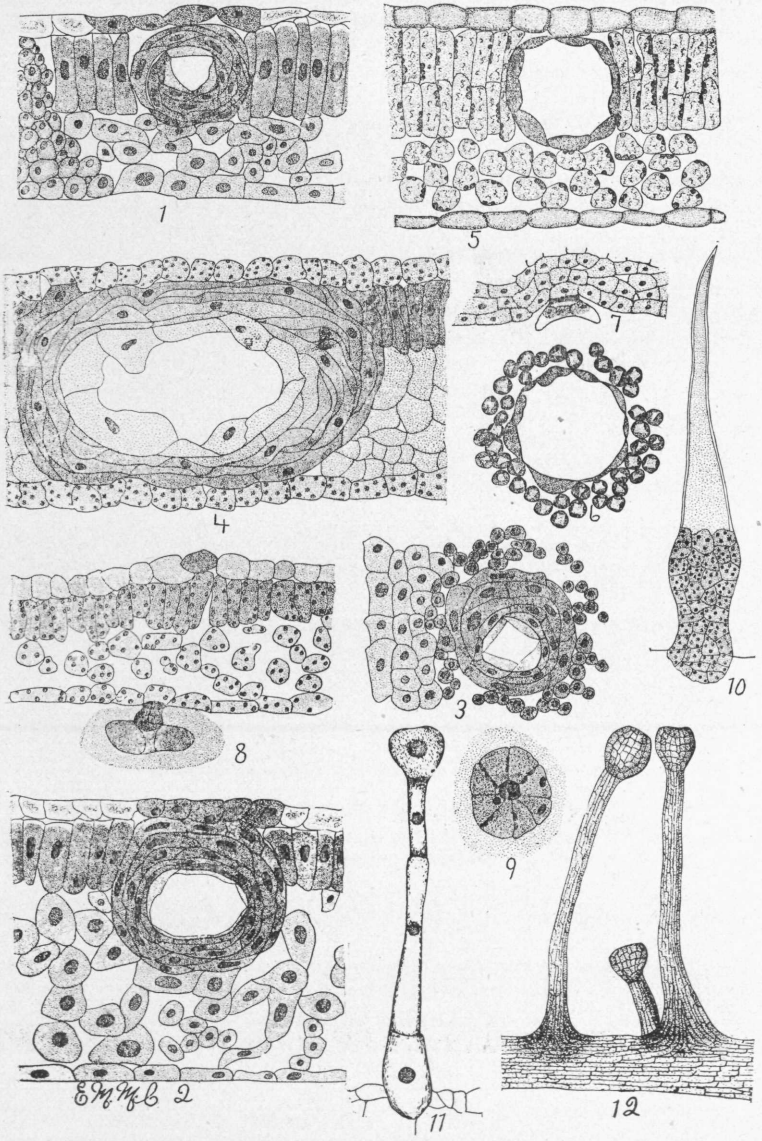
Glandular Hairs and Emergences.

Juglans cinerea L.
Ostyra virginiana (Mill.) Willd.
Corylus americana Walt.
Urtica dioica L.
Urtica gracilis L.
Chenopodium botrys L.
" ambrosioides L.
Blitum capitatum L.
Allionia hirsuta Pursh.
Silene virginica L.
" rotundifolia Nutt.
" regia Sims.
" caroliniana Walt.
" antirrhina L.
" noctiflora L.
Polanisia graveolens Raf.
Drosera rotundifolia L.
" intermedia Hayne.
Sullivantia sullivantii (T. & G.) Britt.
Heuchera americana L.
Rubus odoratus L.
" phoenicolasius Maxim.
" nigrobaccus Bailey.
Drymocallis arguta (Pursh.) Rydb.
Agrimona hirsuta (Muhl.) Bickn.
" striata Michx.
Rosa setigera Michx.
" canina L.
" rubiginosa L.
" gallica L.
Crataegus coccinea L.
" rotundifolia (Ehrh.) Borck.
" macracantha Lodd.
" mollis (T. & G.) Scheele.
Cassia nictitans L.
" chamaecrista L.
" marylandica L.
Ceanothus ovatus Desf.
Rhexia virginica L.
Phacelia bipinnatifida Michx.
Trichostema dichotomum L.
Scutellaria cordifolia Muhl.
Physalis heterophylla Nees.
Antirrhinum majus L.
Scrophularia marylandica L.
Pentstemon cobaea Nutt.
Gratiola virginiana L.
Dasystoma pedicularia (L.) Benth.

Martynia louisiana Mill.
Ruellia strepens L.
" strepens micrantha (Engelm & Gray) Britt.
" ciliosa Pursh.
Triosteum perfoliatum L.
" angustifolium L.
Gnaphalium decurrens Ives.
Anthemis cotula L.
Woodsia obtusa (Spreng.) Torr.
Dennstaedtia punctilobula (Michx.) Moore.
Phegopteris hexagonoptera (Michx.) Fee.
Tofieldia glutinosa (Michx.) Pers.
Cypripedium acaule Ait.
" reginae Walt.
" caudidum Willd.
" hirsutum Mill.
Cypripedium parviflorum Salisb.
Peramium pubescens (Willd.) MacM.

Explanation of Plate XIII.

Fig. 1. Cross section of leaf of Xanthoxylum americanum Mill. showing position and character of a normal internal gland.
Fig. 2. Cross section of leaf of Xanthoxylum americanum showing an unusually large gland.
Fig. 3. Longitudinal section of gland of Xanthoxylum americanum.
Fig. 4. Cross section of leaf of Boebera papposa (Vent.) Rydb., showing internal gland.
Fig. 5. Cross section of leaf of Hypericum prolificum L., showing position and character of internal gland.
Fig. 6. Longitudinal section of gland of Hypericum prolificum.
Fig. 7. Section of leaf of Glecoma hederacea L. showing external scale.
Fig. 8. Cross section of leaf of Gaylussacia resinosa (Ait.) T. and G., showing position and character of an external secreting scale.
Fig. 9. Section of scale of Gaylussacia resinosa, showing central stalk cell.
Fig. 10. Glandular hair of Urtica dioica L.
Fig. 11. Glandular hair of Cypripedium reginae Walt.
Fig. 12. Glandular hairs of Corylus americana Walt.



McCLEERY on "Punctate Glands."